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# Examiners' Report
# June 2011

## GCE Biology 6BI08 01

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# Introduction

Although it is impossible to fully mimic the assessment and learning possible through the carrying out of an individual investigation, we have tried to mirror the marking criteria as far as possible in this international written alternative to the individual investigation.

This paper achieved a full range of marks with all questions, with question 1 more accessible and question 2 more challenging than the June 2010 exam.

With question 3 some candidates still struggled to identify what needed to be included in each section, but many more candidates scored highly on this question this year as they were able to identify and include the key features of an investigation within the context provided.

It was also encouraging to see that more candidates were clearly familiar with the relevant core practicals assessed on this paper than on previous exams.

Key areas of weakness for some candidates tackling this paper include consideration of the value of preliminary work, how to control variables, application of knowledge and understanding and how to analyse and evaluate data obtained.

The mean mark for the paper was 27.3 (out of 50 max) with a standard deviation of 8.3.

## *Question 1 (a) (b)*

1(a) This question was very well answered by the majority of candidates with many scoring 4 or 5 out of the available 5 marks. Many candidates included a high level of specific detail, particularly when considering how to set up and count the number of brine shrimps hatched. This demonstrated that most candidates had an effective knowledge and familiarity with the core practical this question referred to. Unfortunately some candidates neglected to identify a dependent variable, consider the range of temperatures that would be suitable to test or the length of time that the brine shrimps/seedlings should be left at each temperature before measuring/counting.

Some candidates did not appreciate the difference between a seed and a seedling which resulted in some confusion and difficulty in writing a coherent method.

1(b) On the whole part (i) was well answered with many candidates able to identify one or two suitable variables. The most common mistake here was using a vague term such as amount, content or availability as a variable rather than something that could be more precisely measured such as mass or concentration.

Part (ii) was often poorly answered as candidates often did not describe how their chosen variable could be controlled or what effect the variable could have on the dependent variable measured.

This is an example of a good response that scored the maximum marks available: 5 for (a) and 2 each for (bi) and (bii).

**Answer ALL questions**

**1** Many scientists are concerned about the effect climate change could have on the development of organisms. Climate change could have an effect on the yield of many important farmed foods, such as maize, wheat, rice and fish.

(a) Describe an experiment to investigate the effect of temperature (the independent variable) on the development of organisms such as seedlings or brine shrimps. Include details of a suitable **dependent** variable.

**(5)**

- Determine the hatch rate of brine shrimp eggs as temperature increases
- Dissolve 2g of salt in 100cm³ of distilled water in a beaker.
Repeat this step for 5 beakers. ~~different~~
- Obtain brine shrimp eggs from the same species/type and place ~~them~~ a small amount on a white piece of paper. Using a graph paper gently pick up at least 40 → count with a magnifying glass for 40 eggs
Paper with
- Place 40 brine shrimp eggs in each of 6 beakers - remove paper after 1 minutes.
- Place beakers in a range of temperatures - eg 10°C, 20°C, 30°C, 35°C, 40°C using a water bath to maintain these temperatures.
- Make sure that light intensity is the same → keep all variable constant.
- Allow 48 hours for brine shrimp to hatch.

- Measure number of hatched brine shrimp by shining 60W lamp to beaker → use magnifying glass to count the hatched brine shrimps → calculate % (percentage of hatched shrimps) → release shrimps to recovery tank after.

(b) (i) State **two** variables, other than temperature, which could affect this investigation.

**(2)**

- The salinity of the distilled water

- The pH of the distilled water

(ii) Choose **one** of the variables from (i). Suggest how this variable could have been controlled. Describe what effect it could have had on the results if it had not been controlled.

**(2)**

Variable pH of distilled water

How to control the variable Use a buffer solution eg pH8

Effect on the results if the variable had not been controlled If the pH was [redacted] low, it would be acidic → brine shrimp egg may not hatch as the enzymes could be denatured. Hatch rate will decrease. This is the same result if pH was high ie 14 → hatch rate decrease because solution too alkaline.

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**Examiner Comments**

(a) The candidate has clearly identified the dependent variable and how to measure it. They have specified a suitable range of temperatures and time period, and thought about the source of the brine shrimp eggs.
(bi) two clear measurable variables are identified.
(bii) A suitable method of controlling the variable is stated, together with recognition of the potential effect on the results if the variable had not been controlled.

This question scored 4 of the available 9 marks.

**Answer ALL questions**

**1** Many scientists are concerned about the effect climate change could have on the development of organisms. Climate change could have an effect on the yield of many important farmed foods, such as maize, wheat, rice and fish.

(a) Describe an experiment to investigate the effect of temperature (the independent variable) on the development of organisms such as seedlings or brine shrimps. Include details of a suitable **dependent** variable.

**(5)**

The experiment will be carried out using petri dishes containing ~~seeds~~ certain number of seeds stored and monitored in 5 different temperature conditions. ~~The seed~~ For example, 20 mustard seeds is placed in each of the five petridishes containing coton wool damped in distilled water. Each petri dish is labled and stored in different temperatures and left for it to grow for a week. The ~~seeds~~ petridishes would be taken out to measure the average rate of growth with each temperature by messuring the length of shoot. Experiment should be repeated 3 times to increase velidity. The dependant variable in this experiment is the temperature.

(b) (i) State **two** variables, other than temperature, which could affect this investigation.

**(2)**

Amount of water and amount of light that reaches the leaves.

(ii) Choose **one** of the variables from (i). Suggest how this variable could have been controlled. Describe what effect it could have had on the results if it had not been controlled.

**(2)**

Variable Amount of light

How to control the variable Keep the petridishes in the dark.

Effect on the results if the variable had not been controlled The growth of shoots would be different. Less light would've shunted growth ~~after~~ compared to more light.

**ResultsPlus**

**Examiner Comments**

(a) The candidate has clearly identified the dependent variable and how to measure it. They have specified a suitable range of temperatures and time period, and thought about the source of the brine shrimp eggs.
(bi) Two clear measurable variables are identified.
(bii) A suitable method of controlling the variable is stated, together with recognition of the potential effect on the results if the variable had not been controlled.

**ResultsPlus**

**Examiner Tip**

In preparing for this paper candidates should have a good look at all of the core practicals in the specification and make sure they understand the underlying biological principals being explored as well as the practical techniques employed.
Make sure all variables identified are measureable.

## *Question 1 (c)*

This question required candidates to apply some of their knowledge and understanding of the specification. The majority of students managed to get one mark for recognising that enzymes are involved in processes linked to GPP and/or NPP. Many candidates knew how to write out the NPP = GPP – respiration equation but not many understand the relationship between enzymes, photosynthesis and respiration or read the stem of the question to guide them towards a reasonable explanation of the relationship. Most candidates simply related a rise of temperature to a decrease in NPP because enzymes denature ignoring the stated rise in GPP.

Some candidates thought this question was about transpiration rates or even homeostatic mechanisms to help keep plants at a constant body temperature!

This response scored the maximum 4 marks available.

(c) Some plants are adapted to live in low environmental temperatures. When the environmental temperature increases the gross primary productivity increases, but the net primary productivity decreases. This may cause the yield of some crops to decrease.

Explain why an increase in environmental temperature causes the yield of some crops to decrease.

**(4)**

When temperature increases, more kinetic energy is supplied to enzyme and substrate molecules. More chances of collision between enzyme and substrate to form enzyme-substrate complexes. This increases the rate of light independent reaction, producing high amounts of glucose and organic molecules which increases the rate of photosynthesis as photosynthesis is an enzyme controlled process. However, respiration is also enzyme controlled process. With high temperatures, more glucose is needed to be used as respiratory substrate to synthesise high amounts of ATP. Thus, less organic molecules can be converted to starch to be stored in the plant and cellulose to form structures. This will decrease the yield of crops.

**ResultsPlus**

**Examiner Comments**

This candidate demonstrates a good understanding of the relationship between temperature, enzyme activity, photosynthesis, respiration and yield. To be even better they could have made reference back to GPP and NPP mentioned in the question stem.

This response scored 1 mark.

(c) Some plants are adapted to live in low environmental temperatures. When the environmental temperature increases the gross primary productivity increases, but the net primary productivity decreases. This may cause the yield of some crops to decrease.

Explain why an increase in environmental temperature causes the yield of some crops to decrease.

**(4)**

As temperature increase, the ~~to~~ kinetic energy also increase, which will cause the proteins to be broken down and then gets denatured. As all the enzymes gets denatured, the plant will start to loss function. In addition to that, the net primary productivity ~~is~~ decreases, because the plant will ~~make to~~ use energy to maintain its ~~is~~ temperature. Also, an increase in temperature will make the seeds of the crops unable to survive, so it won't grow.

**ResultsPlus**

**Examiner Comments**

This response recognises that enzymes are part of the explanation, but they ignore the rise of GPP and explain a decrease in photosynthesis. This candidate also appears to think that plants are warm blooded and able to maintain their body temperature.

This response scored no marks.

(c) Some plants are adapted to live in low environmental temperatures. When the environmental temperature increases the gross primary productivity increases, but the net primary productivity decreases. This may cause the yield of some crops to decrease.

Explain why an increase in environmental temperature causes the yield of some crops to decrease.

**(4)**

when environmental temperature increases, rate of transpiration increases as well. ~~Hence~~ Hence, there is a greater heat loss by transpiration as energy ~~is~~ from the plant is absorbed by water vapour and diffuses to the surrounding. This causes less energy to be available for the plant during photosynthesis. therefore, less glucose is produced for the growth of the plant.

**ResultsPlus**

**Examiner Comments**

Many candidates explained the fall in NPP through transpiration rates. This candidate also appears to think that heat energy is directly used by the plant in photosynthesis and that cooling from transpiration will cool the plant by more than the rise in the environmental temperature.

**ResultsPlus**

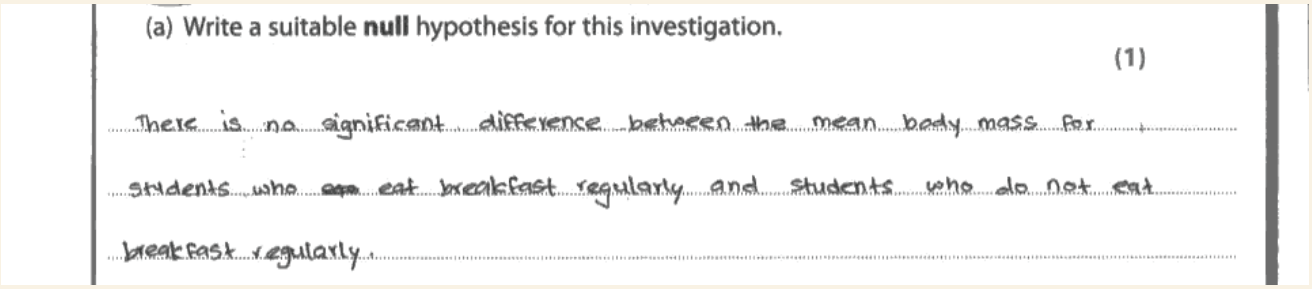
**Examiner Tip**

Candidates must read the stem of questions carefully to help them understand the context for the question. They should also make sure they are familiar with the rest of the GCE specification so they can make use of their knowledge and understanding of Biology to meet the requirements of this paper.

## *Question 2 (a)*

Many candidates understood what a null hypothesis is, but failed to be specific in how they stated it. For example many just said their will be no change/effect/correlation, etc. without reference to testing if it is 'significant'. Other candidates didn't identify what was being compared to see if there was no significant difference.

This response scored the one mark available.


(a) Write a suitable **null** hypothesis for this investigation.

**(1)**

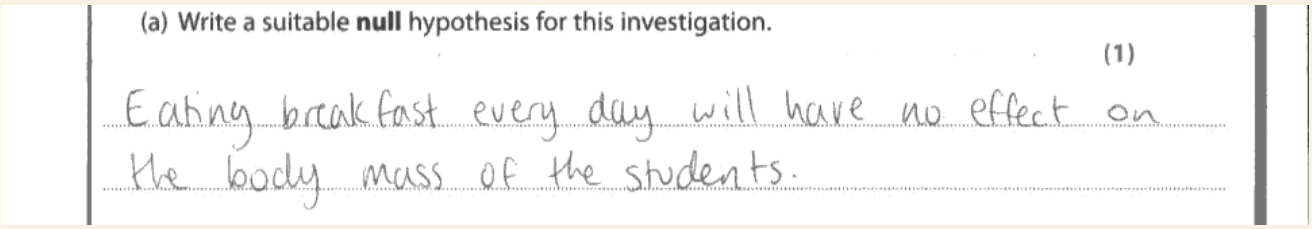
There is no significant difference between the mean body mass for students who ~~are~~ eat breakfast regularly and students who do not eat breakfast regularly.

**ResultsPlus**

**Examiner Comments**

The candidate recognises what is being compared and what is meant by a null hypothesis.

No marks scored for this response.


(a) Write a suitable **null** hypothesis for this investigation.

**(1)**

Eating breakfast every day will have no effect on the body mass of the students.

**ResultsPlus**

**Examiner Comments**

This candidate failed to include 'significant' in their response. This should be included when making statistical comparisons.

This response scored no marks.

(a) Write a suitable **null** hypothesis for this investigation.

(1)

That there is no significance difference between the body mass of students and having breakfast everyday.

**ResultsPlus**
**Examiner Comments**

This response is typical of those who just compared the variables in their null hypothesis rather than looking at what was being compared in the investigation i.e. the two groups of students.

## *Question 2 (b)*

The table was quite discriminating, achieving a full range of marks from 0 to 4.

Many candidates achieved all 4 marks available but some candidates made errors in calculating the means, often errors in rounding up or down the calculated numbers or using an inappropriate number of significant figures. Candidates should be made aware that the number of decimal places in a calculated value is directed by the number of decimal places in the data collected.

Other candidates referred to weight rather than mass, or failed to set out the data in a clear manner. Some candidates still include units in the body of the table rather than with the column headings.

This response scored all 4 marks available.

(b) Prepare a suitable table to display the data obtained and calculate the mean body mass for students who regularly eat breakfast and those who do not.

**(4)**

| Students who eat breakfast | | Students who do not eat breakfast | |
|---|---|---|---|
| Student | body mass/kg | Student | body mass/kg |
| A | 66 | C | 63 |
| B | 55 | E | 72 |
| D | 68 | F | 65 |
| H | 58 | G | 71 |
| J | 61 | I | 75 |
| L | 59 | K | 73 |
| Mean | 61 | Mean | 70 |

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**Examiner Comments**

The two means have been calculated correctly and have been recorded with the same number of significant figures as the raw data. The table is clear with suitable column headings and units for body mass.

This response scored 2 of the 4 marks available.

(b) Prepare a suitable table to display the data obtained and calculate the mean body mass for students who regularly eat breakfast and those who do not.

(4)

| student | weight of student (kg) | | | |
|---|---|---|---|---|
| | regularly ate breakfast | | did not eat breakfast | |
| A | ✓ | 66 | | |
| B | ✓ | 55 | | |
| C | | | ✓ | 63 |
| D | ✓ | 68 | | |
| E | | | ✓ | 72 |
| F | | | ✓ | 65 |
| G | | | ✓ | 71 |
| H | ✓ | 58 | | |
| I | | | ✓ | 75 |
| J | ✓ | 61 | | |
| K | | | ✓ | 73 |
| L | ✓ | 59 | | |
| mean weight/kg | 61.17 | | 69.83 | |

**ResultsPlus**

**Examiner Comments**

This response scored one mark for the calculation of the two means because they used an inappropriate number of decimal places. They also labelled the table with weight rather than mass.

## *Question 2 (c) (d) (e)*

2(c) Most candidates were able to select an appropriate format and scale for their graphs.

The most common omission was the inclusion of a range bar when plotting the mean values for each group of students. This would be appropriate in this context when making a statistical comparison between calculated means to see if there is a significant difference.

Some candidates made plotting errors, sometimes due to using very awkward scales (It is more important for candidates to plot data accurately than aiming to fill the entire graph paper provided by choosing an awkward scale rather than using the decimal grid provided).

Some candidates failed to label the axes appropriately (e.g. missing off mean mass). Where candidates use a large scale for the y axis they must have a break in the axis such that it starts from zero.

A few candidates plotted bar graphs like a histogram (with the bars touching).

2(d) The majority of candidates were able to interpret the significance of the calculated t value and the critical value table at the correct significance/confidence level and therefore scored 2 of the available 3 marks.

A few candidates got mixed up between significance, confidence and probability levels referring to the term in relation to the values they were quoting.

Many candidates only stated their conclusions in terms of the null hypothesis, or stated that there was a significant difference between the two groups rather than writing a conclusion stating which group had a significantly higher mean mass. The significance of the difference and a direction for the conclusion should be included.

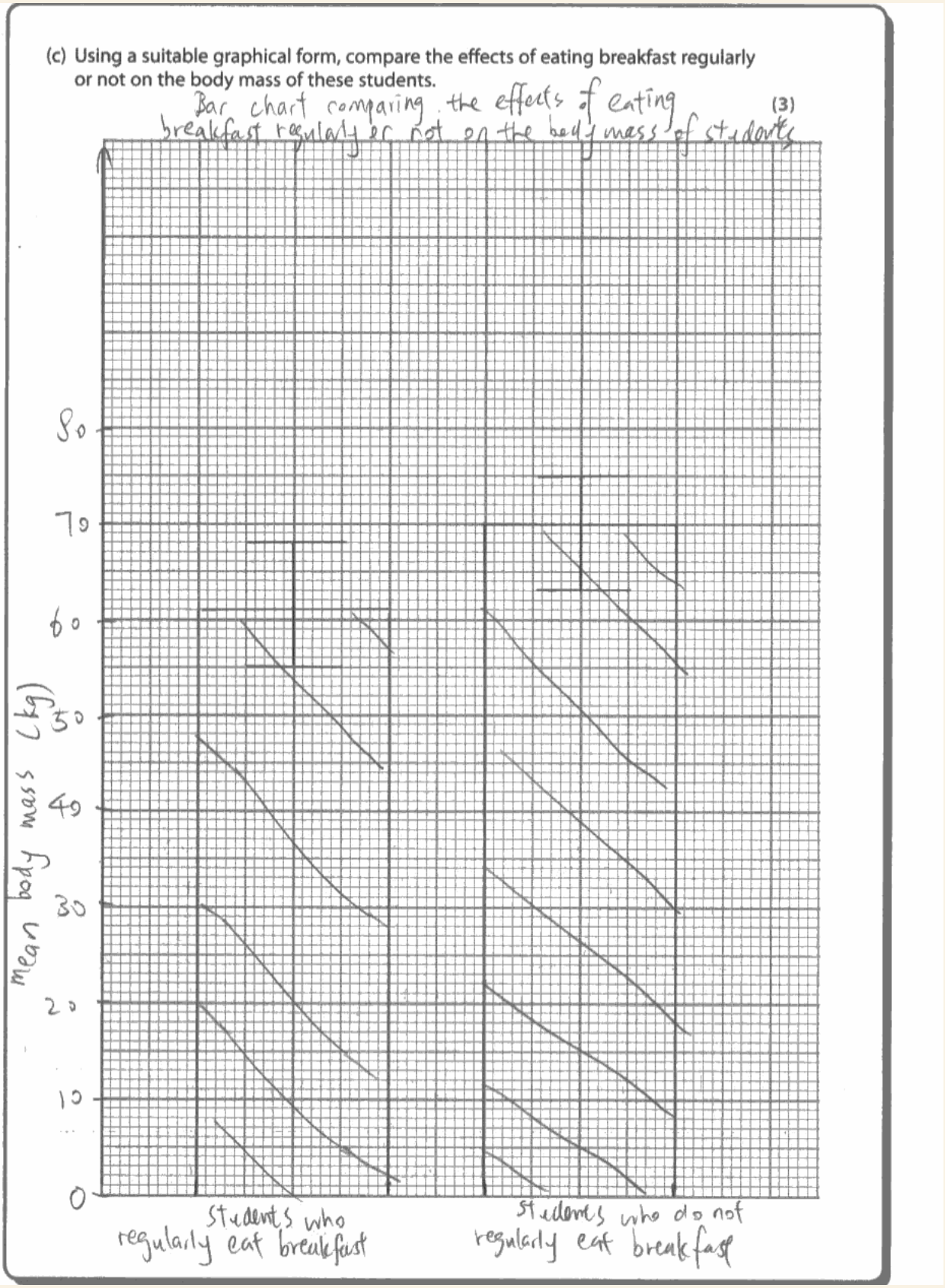
2(e) Most candidates scored at least one mark for providing one (or several) examples of variables that had not been taken into account (marking point 2) and many realised the significance of the small sample size.

Surprisingly many candidates missed marking point 1 for recognising that there were severable variables which weren't properly standardised or controlled.

Only a few candidates recognised that measuring mass change over time or BMI would be a more valid measure for investigating the effect of eating breakfast.

This response scored all 9 marks available.

(c) Using a suitable graphical form, compare the effects of eating breakfast regularly or not on the body mass of these students. (3)



(d) The student applied a *t*-test to the data she obtained.
She obtained a result of $t = 3.09$ from her calculation.

The table below shows critical values of *t* with 10 degrees of freedom, at different significance levels.

| Significance level (p) | 0.05 | 0.01 | 0.001 |
|---|---|---|---|
| Critical value of *t* | 2.23 | 3.17 | 4.59 |

What conclusions can be drawn from this investigation?

Use the information provided in the table above and in the graph you have drawn.

(3)

3.09 ~~3.09~~ The calculated value of t is higher the critical value of t at ~~significant~~ 0.05 significance level (95% confidence limit), which is 2.23. Therefore, the null hypothesis is rejected. There is significant difference between the mean body mass of students who regularly eat breakfast and those who do not. There is evidence to suggest ~~The mean body mass of~~ students who do not regularly eat breakfast have a higher mean body mass than those who do.

(e) Suggest why it may **not** be reasonable to draw a firm conclusion from the results of this investigation.

Only a small sample size is used, twelve students, which may not be the representative of the whole population. The t-test can only show that there is significant evidence to ~~show that~~ believe the null hypothesis is incorrect at 95% confidence, but do not show it is correct at 100% confidence level.

There are factors such as gender of students, ~~as~~ which may affect the body mass. However, no information about that is given, ~~and are don~~ so these factors which should have kept constant but are not controlled. So, this is not a fair test.

**(Total for Question 2 = 14 marks)**

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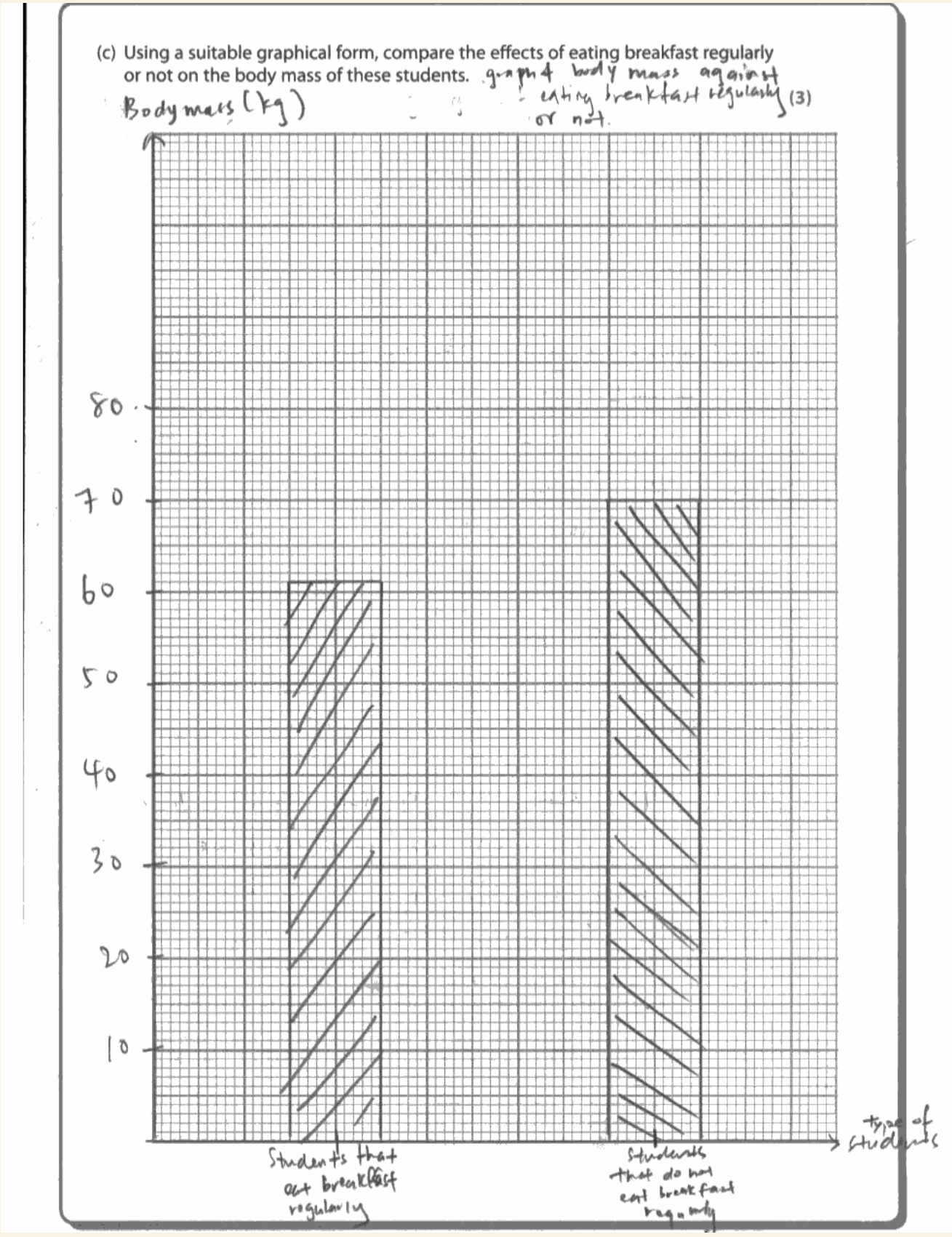
**Examiner Comments**

(c) Appropriate graph drawn and well labelled, accurately plotted with range bars included.
(d) The significance of the calculated value of t interpreted correctly in relation to 95% confidence limits. Significance and direction of difference recognised.
(e) Small sample size and other factors (including examples) recognised.




This response scored 4 of the 9 marks available.

(d) The student applied a *t*-test to the data she obtained.
She obtained a result of $t = 3.09$ from her calculation.

The table below shows critical values of *t* with 10 degrees of freedom, at different significance levels.

| **Significance level (p)** | 0.05 | 0.01 | 0.001 |
|---|---|---|---|
| **Critical value of *t*** | 2.23 | 3.17 | 4.59 |

What conclusions can be drawn from this investigation?

Use the information provided in the table above and in the graph you have drawn.

(3)

~~The t-value obtained at 0.05 significance level is large~~

The t-value ~~obtained~~ 3.09 obtained at 0.05 significance level is larger than the critical value ~~of~~ of t which is 2.23. Thus, there is significant difference between ~~the~~ eating breakfast regularly or not and the body mass of students. The null hypothesis is rejected.

(e) Suggest why it may **not** be reasonable to draw a firm conclusion from the results of this investigation.

(3)

The gender of students ~~taken~~ in the experiment may not be the same. The types of food the students eat may not be the same and the age of students may not be the same. This ~~the~~ experiments only counts for breakfast, ~~the type~~ it does not counts for lunch and dinner too. So, it may not be reasonable to draw ~~a firm~~ a firm conclusion.

**ResultsPlus**

**Examiner Comments**

(c) Suitable graph chosen and plotted correctly. However, no range bar included and y axis label misses reference to mean results.
(d) Correct interpretation of the calculated value of t at the correct significance level, but no direction provided in the conclusion.
(e) List of variables that should have been considered provided - so only mark point 2 covered.

## *Question 3*

Unfortunately some candidates appeared not to read the stem of the question and take time to really understand what is expected of them in the answer, for example, by ignoring the stated hypothesis and that a dentist was providing extracted teeth for the investigation.

(a) Some candidates still did not understand this part of the question and wrote general statements to do with the method and did not refer to any safety or ethical issues. Several candidates gave examples of precautions taken without the reasons why they were needed.

A significant minority of candidates ignored the stem of the question and thought that they would have to extract the teeth themselves hence: *"do not let the patient bite your hand."* and recognise that extracting teeth or force feeding people only one type of drink for a prolonged period might give rise to some health and ethical issues!

(b) There were a lot of good responses to this part of the question. However, some candidates clearly still do not understand the value and purpose of preliminary work. Many candidates did not identify the need to determine an appropriate dependent variable.

There are a significant number of candidates that treat this section like the method, rather than using it to check out ideas to find the best method to do the experiment.

(c) It was encouraging to see some excellent investigations here with candidates demonstrating a clear understanding of experimental procedure and therefore scoring between 8 and 10 marks for this part of the question.

However, it is surprising that many candidates actually fail to state the independent and dependent variable to be investigated.

Most candidates gained at least two marks for identifying two variables which needed to be controlled but many candidates failed to explain how to control them.

There is still a significant amount of confusion with many candidates between measuring and controlling variables. Some gave details of how to measure a range of factors without making it clear how doing this would help to cope with variation, for example many candidates appear to think that you can control temperature with a thermometer and control pH with a pH meter. We even had several candidates measuring humidity with whirling hygrometers inside their orange juice solutions. Several candidates wrote at length about variables to control and very little else, so their method was incomplete.

There are still a significant number of candidates who think repeats are taking the same measurement a number of times or doing the experiment again with different pH's.

Few candidates explained why certain variables would need to be controlled in this investigation.

A minority of candidates planned to experiment with real people, poor things and some planned to take whole sets of teeth from their victims. There were candidates who thought they were going to make alkaline solutions by diluting orange juice, showing a complete lack of understanding of pH. Others confused pH with the concentration of citric acid and DCPIP and spent most of their time writing about the vitamin C core practical. Some candidates couldn't even remember the name of universal indicator.

A significant number of candidates gave the rate of decay without giving any idea of what they were measuring anywhere in their answer.

The quality of written communication was very variable. Many reports were disorganised and some were very difficult to follow. The use of scientific vocabulary was variable. Spelling varied considerably. Grammatical errors were due to the disjointed descriptions given by many candidates.

(d) Some candidates did not understand what was expected of this section and just used it to finish the method here and put what they would measure etc.

Tables were often poor with correct headings missing (not helped by candidates not being clear about what they wanted to measure as a dependent variable). Means were often considered but not always correctly.

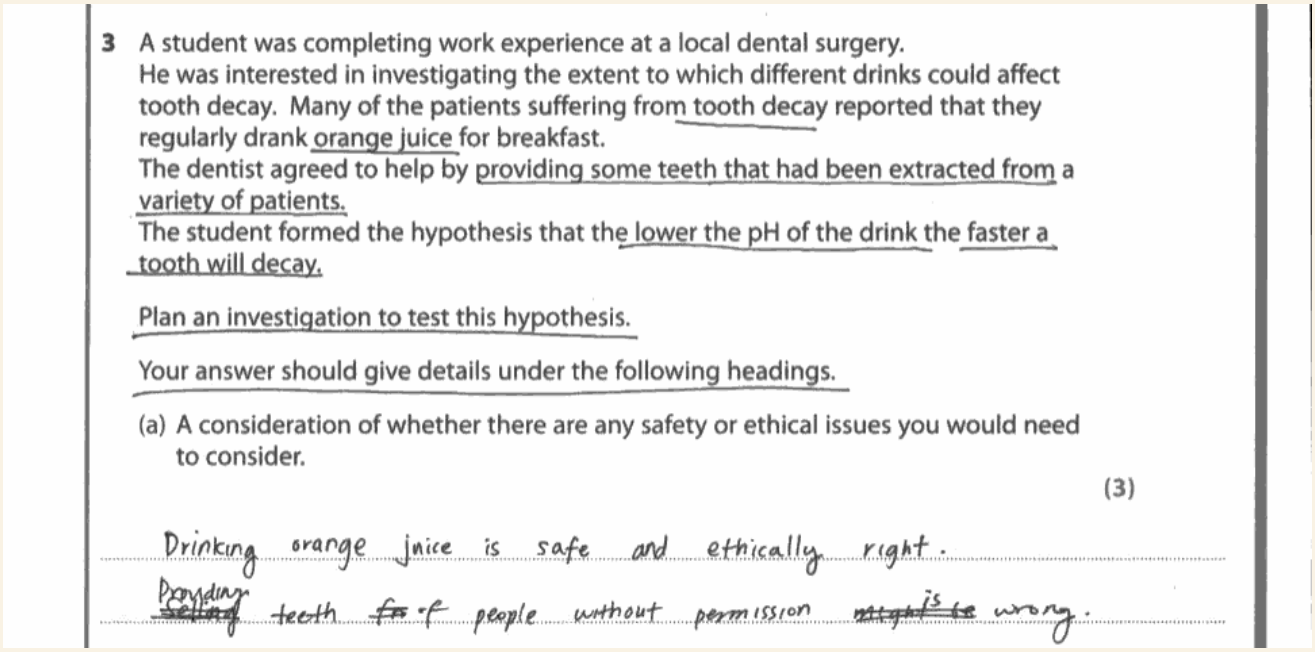
Graphs varied considerably. A number of candidates chose the correct format for the data suggested from their table. The table is problematic for several candidates because they do not keep them simple. Headings are often not explanatory or do not match the method. Units are often forgotten or are incorrect. Means appear from nowhere, so it is not obvious that they are from repeats using the same pH. Many realised that the graph should be a scatter graph or line graph, but the axes were often carelessly labelled or the mean not stated.

It should be noted that those candidates who describe the table and graph rarely earn full marks from them as there is a lot to include, it is easier for candidates to show what needs to be included if they draw out the table and the graph.

A number of candidates chose the correct statistical test for their data, t-tests, Mann Whitney U and Spearman's rank being the main ones chosen. However many students did not know which test was suitable for the data as they had presented and proposed statistical tests that were inappropriate to what they were proposing to do e.g. suggesting a t-test for a scatter diagram or applying it for all their results instead of comparing two means only. Few candidates gained the mark for a clear justification for the statistical test chosen, often a combination of sufficient samples and what the test shows.

(e) Most candidates gained one mark for recognising one or more variables that needed to be taken into account (or even a whole string of them) and many candidates made the more general point that there were a number of variables which were not controlled or standardised. In a good answer the examples flowed on naturally from this. The best responses recognised that the conditions in a test tube do not represent the natural decay conditions in the mouth and that measuring decay is difficult and that measuring the loss of mass of a tooth may not be a measure of the natural rate of decay of a tooth.

This response scored 8 of the 23 marks available.



**3** A student was completing work experience at a local dental surgery.
He was interested in investigating the extent to which different drinks could affect tooth decay. Many of the patients suffering from tooth decay reported that they regularly drank orange juice for breakfast.
The dentist agreed to help by providing some teeth that had been extracted from a variety of patients.
The student formed the hypothesis that the lower the pH of the drink the faster a tooth will decay.

Plan an investigation to test this hypothesis.

Your answer should give details under the following headings.

(a) A consideration of whether there are any safety or ethical issues you would need to consider.

**(3)**

Drinking orange juice is safe and ethically right.
Providing ~~selling~~ teeth ~~fo~~ of people without permission ~~might be~~ is wrong.

(b) Suggestions for preliminary work that you might undertake to ensure your proposed method would provide meaningful data.

(3)

Investigate people who drink orange juice for breakfast to get initial state of teeth. And record the type of juice they drink to check pH of juice. Check ~~peple~~ people's dental records which will show their ~~overall~~ previous tooth decay ~~so that~~ to know ~~orange juice will be the only independent variable~~ · how often those people get tooth decay. ~~to~~ . ~~which means~~

(c) A detailed method that includes the reasons for your choice of apparatus and technique, and how important variables are to be controlled or monitored.

(10)

Prepare different pH of orange juice ~~E~~ 5. 4. 3. (pH).

~~10 people~~ Each 3 people will drink different pH of orange juice. ~~Orange~~ Different pH of juice is provided to 3 people (same amount of 500mL) every morning for one month.

~~They are~~ ~~Then record the state of tooth decay~~

People are asked to brush their teeth after drinking juice. And whenever they eat something so that other food cannot be the cause of tooth decay.

After one month, ~~people are~~ the state of tooth decay are recorded and experiment are repeated 3 more times to get a reliable data.

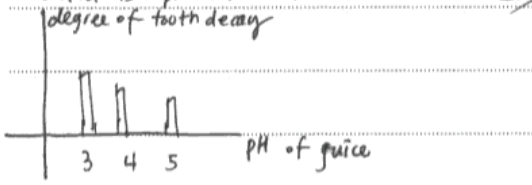
(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation.

(4)

Data is recorded in table

| pH of orange juice | degree of tooth decay |
|---|---|
| 3 | |
| 4 | |
| 5 | |

Data is presented in bar chart




Data is analysed by using t-test

compare the data with critical value at 5% significance level and determine wheather data is relevant with null hypothesis

If the value is bigger than critical value reject null hypothesis

## ResultsPlus

**Examiner Comments**

(a) This response only just got one mark for making a comment about ethical issues i.e. permission should be sought.
(b) Some consideration has been made about gathering inital information before conducting the experiment, but little of the information will have direct relevance to the design of the investigation.
(c) Candidate has recognised dependent and independent variables, but not clearly stated them. Method does not state how to measure the dependent variable, or exactly what repeats are to be made. Time scale is provided together with some consideration of control of other variables (amount to be discouraged), but range of pHs chosen is insufficient. Method is brief, lacks clarity and is not well expressed.
(d) Format of table and graph suitable, but no units provided for the very vague dependent variable heading. Lack of clarity of repeats does not lend support to the consideration of repeats made in part (c). Reference to t-test should consider what is being compared - 2 sets of pH or all values? This does not show a good grasp of what the chosen test is for.
(e) List of other factors provided that could have affected results so mark point 2 awarded.

This response, although not perfect, is an example of a response sufficient to reach all 23 marks available.

**3** A student was completing work experience at a local dental surgery.
He was interested in investigating the extent to which different drinks could affect tooth decay. Many of the patients suffering from tooth decay reported that they regularly drank orange juice for breakfast.
The dentist agreed to help by providing some teeth that had been extracted from a variety of patients.
The student formed the hypothesis that the lower the pH of the drink the faster a tooth will decay.

Plan an investigation to test this hypothesis.

Your answer should give details under the following headings.

(a) A consideration of whether there are any safety or ethical issues you would need to consider.

(3)

The safety issues are

Some extracted teeth may have harmful bacteria growing on it. And also, some teeth may have viruses from the patient it was extracted form. It is safer to wear gloves and face mask when carrying out the experiment. It is dangerous when dealing with solutions of low pH, as acid can corrode skin.

Some ethical issues are that some patients may not be comfortable with their extracted teeth being experimented on. It is wrong to use the extracted teeth of the patients without getting their consent first. Other than that, there really isn't any significant ethical issues.

(b) Suggestions for preliminary work that you might undertake to ensure your proposed method would provide meaningful data.

(3)

Obtain extracted teeth samples to carry out experiment on.
Practice the proposed method.
Determine other variables that need to be taken into account.
Determine the appropriate dependant variable.
Determine the suitable timescale to check for decaying of teeth.
Read up on research by other scientists.
Get consent of patients whom teeth are extracted from.
Determine how the decaying stage of teeth look like.

(c) A detailed method that includes the reasons for your choice of apparatus and technique, and how important variables are to be controlled or monitored.

(10)

~~The independant variable here is the pH of~~
The experiment is carried out by leaving a tooth each in buffer solutions of different pH. The dependant variable is the time taken for the tooth to decay. It is determined by checking on the tooth everyday. A stopwatch is started when the tooth is immersed into the buffer solution. The independant variable is the pH of the buffer solution the tooth is immersed in. Buffer solutions of pH 2, 2.5, 3, 3.5, 4, 4.5, 6.0, 6.5, and 7 are used. The pH of the solution will be tested by using a pH meter.

One ~~abiotic factor~~ variable that can affect the result is the ~~amount~~ volume of buffer solution used. Each beaker is filled with 25 mL of buffer solution by using a pipette.

Another abiotic factor is the temperature of the ~~water~~ buffer solution. ~~The~~ All the beakers are placed into water baths ~~at~~ at 25°C, ~~That is a thermometer~~ to keep temperature constant.

~~Another~~ Another abiotic factor is the ~~buffering~~ mineral content of the solution. ~~The buffer solution~~ The buffer solution is made by adding various amount of distilled water (which has 0% minerals) to weak acid and it's conjugate salt.

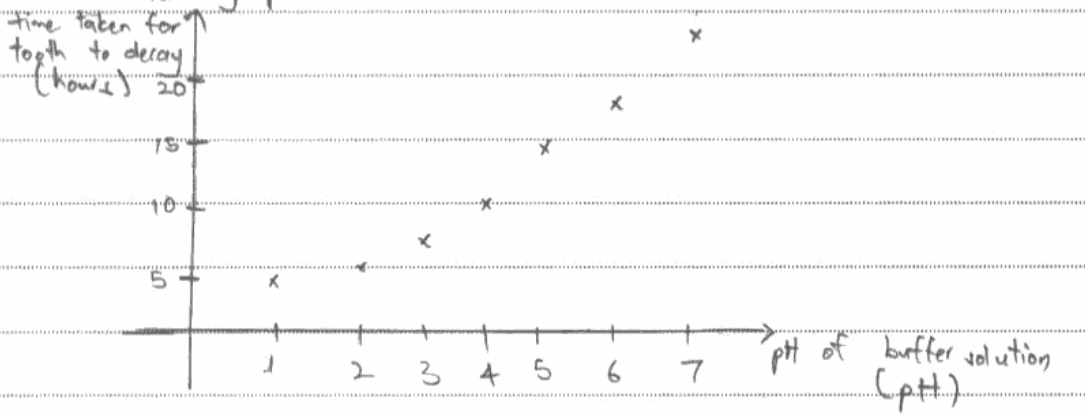
~~An~~ An image of a decayed tooth is obtained from a dentist. The tooth ~~used~~ used in the experiment is ~~determined~~ said to ~~be~~ have decayed when it looks similar to the image. The teeth immersed in the solutions are checked on ~~every hour~~ every hour to see if any have decayed.

The whole experiment is repeated 3 times.

(d) A clear explanation of how your data are to be recorded, presented and analysed in order to draw conclusions from your investigation. (4)

| pH of buffer solution (pH) | Time taken for tooth to decay (hours) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | mean |
| 2·0 | | | | | |
| 2·5 | | | | | |
| 3·0 | | | | | |
| 3·5 | | | | | |
| 4·0 | | | | | |
| 4·5 | | | | | |
| 5·0 | | | | | |
| 5·5 | | | | | |
| 6·0 | | | | | |
| 6·5 | | | | | |
| 7·0 | | | | | |

A scatter graph is drawn




Statistical test is used. In this case, a Spearman's rank correlation test is carried out. The null hypothesis for the experiment is, there is no significant correlation between pH of buffer solution and the ~~##~~ time taken for tooth to decay.

(e) The limitations of your proposed method.

(3)

The tooth is obtained from different patients.

It is hard to control all the abiotic factors.

The decaying of the tooth is also dependant on the genetics of the patient it is obtained from.

It is hard to determine ~~the end~~ when a tooth begins to decay.

Experimental conditions may not be similar to real life situations.

**ResultsPlus**

**Examiner Comments**

(a) Two relevant safety issues and an ethical issue have been identified.
(b) Practicing the method, determining the dependent variable and identifying the likely timescale for the investigation are all useful elements of preliminary work.
(c) Marks were awarded for: stating the dependent variable and discussing how to measure it; providing a suitable range of different pHs and measuring them with a pH meter and controlling them with buffers; recognising other variables to control and stating how to control them (volume, temperature).
(d) Suitable table, graph and statistical test included including relevant units and clarity of what repeats are to be made and used to calculate the mean. This is added support for repeat mark for (c).
(e) Recognition given to how hard it is to control all variables (with examples) together with consideration of the difficulty of measuring when decay starts and a vague comment about the experimental conditions not matching 'real life' situations.

**ResultsPlus**

**Examiner Tip**

In (c) repeating the whole experiment 3 times is just about worthy of credit, although it would be better if they had stated clearly exactly what was to be repeated. It would also be appropriate if they clearly stated what the independent variable was.

## Paper Summary

To do well on this paper candidates need to think through the context of the question and apply their knowledge and understanding of the core practicals and How Science Works skills and criteria carefully.

If it is not possible for candidates to carry out their own full investigations it should be encouraged that they practice planning and evaluating how to carry out a variety of investigations in a variety of contexts, together with practicing analysing data so that they develop confidence in considering how to present and interpret data. It would also be a good idea to get candidates to make use of the unit 6 investigation criteria as well as the past papers for this unit.

## Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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